Thompson T. Rawls, II
Gali L. Hagel
BellSouth Wireless Cable, Inc.
1100 Abernathy Road
500 Northpark Center, Suite 414
Atlanta, GA 30328

James E. Meyers
Law Office of James E. Meyers, P.C.
1633 Connecticut Ave., N.W., Suite 400
Washington, DC 20009-1041
Counsel for Dallas County Community College District; Tarrant County Junior College District; Richardson Independent School District; Education Service Center Region 10

Quincy Rodgers
Christine G. Crafton
Faye R. Morrison
NextLevel Systems, Inc.
Two Lafayette Centre
1133 21st Street, N.W., Suite 405
Washington, DC 20036

Glenn B. Manishin
Blumenfeld & Cohen
1615 M Street, N.W., Suite 700
Washington, DC 20036
Counsel for WebCel Communications, Inc.

Martin L. Stern
David Rice
Preston Gates Ellis & Rouvelas Meeds, LLP
1735 New York Ave., N.W., Suite 500
Washington, DC 20006
Counsel for WebCel Communications, Inc.

William D. Wallace
Crowell & Moring, LLP
1001 Pennsylvania Avenue, N.W.
Washington, DC 20004
Counsel for Catholic Television Network

Todd D. Gray
Margaret L. Miller
Dow, Lohnes & Albertson, PLLC
1200 New Hampshire Avenue, N.W.
Suite 800
Washington, DC 20036-6802
Counsel for ITFS Parties

Robyn G. Nietert
Rhonda L. Neil
Brown, Nietert & Kaufman, Chartered
1920 N Street, N.W., Suite 660
Washington, DC 20036
Counsel for Wireless One of North Carolina

Robert J. Ungar
Arter & Hadden, LLP
1801 K Street, N.W., Suite 400
Washington, DC 20006
Counsel for Public Television 19, Inc.(KCPT)

Donald J. Evans
William M. Barnard
Evans & Sill, P.C.
919 18th Street, N.W., Suite 800
Washington, DC 20006
Counsel for Alliance of MDS Licensees

Robert F. Corazzini
Suzanne C. Spink
Petter & Corazzini, LLP
1776 K Street, N.W., Suite 200
Washington, DC 20006
Counsel for Region IV Education Service; UT Television; George Mason University Instructional Foundation, Inc.; Humanities Instruction TV Education Center, Inc.

Kathleen A. Cox
Robert M. Winteringham
Corporation for Public Broadcasting
901 E Street, N.W.
Washington, DC 20004-2037

Marilyn Mohrman-Gillis
Lonna Thompson
Association of America's Public Television Stations
1350 Connecticut Avenue, N.W.
Washington, DC 20036

Gregory Ferenbach
Patricia DiRuggiero
Public Broadcasting Service
1320 Braddock Place
Alexandria, VA 22314

Robert A. Woods
Steven C. Shaffer
Malcolm G. Stevenson
Schwartz, Woods & Miller
1350 Connecticut Avenue, N.W., Suite 300
Washington, DC 20036
Counsel for Arizona Board of Regents for Arizona State University; Board of Trustees of Community-Technical Colleges (CT); California State University-Northridge; Catholic Diocese of Youngstown; Connecticut Public Broadcasting, Inc,; Dutchess Community College; Educational Television Association of Metropolitan Cleveland; Hartnell College; Louisiana Education Television Authority; Milwaukee Area Technical College District Board; Mississippi Authority for Educational Television; New Jersey Public Broadcasting Authority; Oregon Public Broadcasting; San Jose State University; Santa Clara County Board of Education; Sarasota County School Board; University of North Carolina; University of Southern California; WHYY, Inc.

Arthur Firstenberg
President
Cellular Phone Taskforce
P.O. Box 100202
Vanderveer Station
Brooklyn, NY 11210

Harry R. Anderson
President and CEO
EDX Engineering, Inc.
P.O. Box 1547
Eugene, OR 97440

Joy M. Taylor

Joy M. Taylor

1

PROPOSED TEXT OF ATTACHMENT TO REPORT AND ORDER SETTING FORTH METHOD FOR PREDICTING ACCUMULATED SIGNAL POWER FROM A MULTIPLICITY OF STATISTICALLY-LOCATED TRANSMITTERS

Major Steps

In carrying out the interference studies required in this section, the aggregate power of the interfering signals to be expected from the response station transmitters shall be determined using a process comprising four major steps, as described below. First, a grid of points shall be defined that is statistically representative of the distribution of transmitters to be expected within the response service area. Second, any regions and any classes of response stations to be used shall be defined. Third, the appropriate transmitter configuration to be used in each interference study shall be determined. Finally, the equivalent power of each of the representative transmitters shall be determined and used in the various required interference studies.

Defining Grid of Points for Analysis

Since it is impossible to know *a priori* where response stations will be located, a grid of points is used to represent statistically in a relatively small number of locations the potentially much larger number of response stations that are likely to be installed in the areas surrounding each of them. Once defined, the same grid of points shall be used by all parties conducting interference analyses involving the subject response station system.

Defining the representative grid of points to use in all the interference studies required in Sections 21.909 and 74.939 begins by geographically defining the response service area (RSA) of the response station hub (RSH). This may be done using a list of coordinates, a radius from the response station hub location, a line on a map, or a similar method sufficient to allow others to duplicate the interference studies to be conducted. Similarly, the coverage areas of any sectors in the RSH receiving antenna must be described geographically. Any overlaps of the sector patterns should be bisected in order to provide definitive borders for interference analysis purposes. The polarization in each sector must be identified.

The RSA may be subdivided into regions to allow different characteristics to be used for response stations in different portions of the RSA. (For details on regions and their use, see the section below on Defining Regions and Classes for Analysis.) Any regions to be used when analyzing interference must also be described in a manner similar to that used to describe the RSA itself. Analysis of the regions involves use of one or more classes of response station characteristics that include combinations of the values for maximum antenna height and for maximum equivalent isotropic radiated power (EIRP) and of the worst case antenna patterns that will be allowed in practice in installations of response stations associated with the various classes within the respective regions. (For details on classes and their use, see the section below on Defining Regions and Classes for Analysis.) Maximum numbers of simultaneous transmissions from response stations associated with each class within each region must be specified as part of the application process.

A line is established surrounding the RSA, following the shape of the RSA boundary, ½ mile outside the RSA, and never more than ½ mile from the RSA boundary at any point. This is termed the "analysis line" and will be used in determining that an adequate number of grid points representing transmitters is being used in the interference analyses. A starting point is defined on the analysis line due north (true) of the response station hub. A series of analysis points is then spaced along the analysis line with the starting point being one of those points. The analysis points must occur at least every ½ mile along the analysis line or every 5 degrees (as seen from the response station hub), whichever yields the largest number of analysis points. When an RSA has a non-circular shape, the choice of distance along the analysis line or angle from the response station hub must be made for each portion of the line so as to maximize the number of analysis points in that portion. The analysis points are to be described by their geographic coordinates. (The results of this method are that, for a circular RSA, a minimum of 72 analysis points will be used, and that, for portions of the analysis line of any RSA more than 5.73 miles from the response station hub, the distance method will be used.)

Now, a grid of points is defined within the RSA to statistically represent the response stations. The grid uses uniform, square spacing of the points, as measured in integer seconds of latitude and longitude, with the first square surrounding the RSH and with its points equidistant from it. The lines connecting the points on one side of any grid square point true north, east, south, or west. The grid is defined so as to include all points within or on the boundary of the RSA, with the exceptions noted below. The result is that the grid can be defined by only two values — the coordinates of the hub and the separation between adjacent grid points in seconds — combined with the description of the RSA boundary.

Any points falling at locations at which it would be physically impossible to install a response station (such as in the middle of a lake, but not the middle of a forest) are removed from the grid. The points of the grid so removed are to be described by their geographic coordinates.

The grid of points is then divided into two groups. The division is to be done using a checkerboard (or quincunx) pattern so that alternating points along the east-west and north-south axes belong to opposite groups and points along any diagonal line belong to the same group.

The combination of the grid of points within the RSA and the points on the analysis line is next used to determine that the number of grid points is truly representative of a uniform distribution of response station transmitters within the RSA. This is done by conducting a power flux density analysis from each grid point within the RSA to each point on the analysis line. For this analysis, a single response station should be assumed to be located at each grid point, that response station having the combined worst case antenna pattern without regard to polarization of all response station classes assigned to that grid point and the maximum EIRP of any response station class assigned to that grid point. (For details on the method for determining the combined worst case antenna pattern, see the section below on Defining Regions and Classes for Analysis.) The response station antennas all should be oriented toward the response station hub.

The analysis of grid point adequacy should be done using free space path loss over flat earth only and should not include the effects of terrain in the calculation of received signal levels. At each point on the analysis line, the power flux density from all grid points in each group of the checkerboard pattern should be aggregated. This is done by converting power received from each assumed transmitter from dBW/m^2 to W/m^2, summing the power in W/m^2 from all transmitters in each group, and then converting the sum back to dBW/m^2.

Once the aggregated power flux density from each of the two groups has been calculated, the received power flux densities from the two groups are compared at each of the points on the analysis line. The power flux densities from the two groups must be within 3 dB of one another at each of the points on the analysis line. In addition, there must be no closer spacing of grid points that allows a difference of greater than 3 dB between the groups. If they are within 3 dB at every analysis point and no closer spacing results in a difference greater than 3 dB at any analysis point, a sufficient number of grid points is included for use in further analyses. If they are not within 3 dB at every analysis point or any analysis point has a difference between the groups of greater than 3 dB, a larger number of grid points (i.e., closer spacing of grid points) must be used so that the 3 dB criterion is met.

In cases in which sectorized response station hubs are used, a further test is required to assure that an adequate number of grid points is used. In addition to meeting the requirements of the preceding paragraph, each sector must contain a number of grid points equal to or greater than the distance from the hub to the furthest point in the sector, expressed in miles, divided by two, with a minimum of five grid points per sector. Should an insufficient number of grid points fall within any sector after meeting the 3 dB criterion, the point spacing for the entire RSA must be decreased until this additional requirement is satisfied.

Defining Regions and Classes for Analysis

To provide flexibility in system design and to assure that the clustering of response stations likely within higher population density areas is properly reflected in interference analyses, regions may optionally be created or, with the exceptions noted below, may be required within response service areas. Regions may be of arbitrary size, shape, and location but must be evaluated on the basis of the uniformity of their population densities in order to preclude unidentified clustering of response stations. The territory within a region must be contiguous. Regions within a single RSA may not overlap one another. Within regions, response stations are apt to be randomly distributed and for analysis purposes are to be assumed to be uniformly distributed. Regions are to be defined by their boundaries in the same manner as is the response service area. (For details on describing boundaries, see the section above on Defining Grid of Points for Analysis.)

While regions may be established virtually arbitrarily, they must be tested to determine that the population densities they represent are reasonably uniform. This is done using postal zip code territories. For each postal zip code within a region, the population of the zip code and its area (in square miles or square kilometers) are used. If a zip code is divided between two (or more) regions, the proportion of the zip code area falling in each region should be calculated and the same proportion of the population of the zip code then should be ascribed to each associated region.

The test for population density uniformity consists of calculating the population density of each zip code within a region and dividing it by the average population density of that region taken as a whole. The resulting value must be three (3) or less. The required relationship can be expressed by the following inequality:

$$\frac{\left(P_{zip} / A_{zip}\right)}{\left(P_{region} / A_{region}\right)} \leq 3$$

Where

P_{zip} = *Population in Zip Code*
A_{zip} = *Area of Zip Code* $\left(mi^2 \text{ or } km^2\right)$
P_{region} = *Population in total Region*
A_{region} = *Area of total Region* $\left(mi^2 \text{ or } km^2\right)$

The requirements for population density testing may be disregarded in cases in which response stations take turns using the channel or subchannel and in which interference analyses are done from each grid point utilizing the maximum antenna height of any class of response station located at each grid point, the maximum effective isotropic radiated power (EIRP) of any class of response station located each grid point, and the combined worst case antenna pattern of all antennas to be used at each grid point.

Within each region, at least one class of response station with defined characteristics must be specified to balance the interference expected to be caused and the types of installations to be made. The classes are to be used in interference analyses and to provide limitations on the installations that may be made in the related region. The characteristics of each such class of response stations will include the maximum height above ground level (AGL) for antennas, the maximum equivalent isotropic radiated power (EIRP), and the combined worst-case antenna radiation pattern – for each polarization when both are used – for all response stations of that class installed. For each defined class of response stations within a region, the maximum number of such response stations that will transmit simultaneously on any channel or subchannel must be specified.

The combined worst-case antenna azimuth radiation pattern is required to be specified collectively for all of the classes of response stations located at each grid point (in the procedure above, in the section on Defining Grid of Points for Analysis, for confirming that the required number of grid points is specified) and individually for each of the classes defined for each region of the RSA. In the case of the collective pattern used to determine adequacy of the number of grid points, if both polarizations are used in the system, the horizontal and vertical azimuth patterns of each antenna should be treated as deriving from separate antennas and should be combined with one another and with the patterns from all the other antennas at that grid point. In the case of the individual patterns for each class used for interference analyses, if both polarizations are used in the system, the horizontal and vertical combined worst-case azimuth patterns should be determined separately for all classes defined. Similarly, the cross-polarized worst-case pattern should be determined for each polarization.

These combined worst-case patterns are derived by setting the maximum forward signal power of all antenna types to be used within the class or classes to the same value and then using the highest level of radiation in each direction from any of the antennas as the value in that direction for the combined antenna pattern. The same method is used to determine both plane- and cross-polarized patterns, which are used separately in interference analyses. The combined worst-case plane- and cross-polarized patterns for each class will be used in all of the interference studies and are not to be exceeded in real installations of response stations within a class to which the pattern applies.

Determining Transmitter Configuration

Several factors in the configuration of a system determine whether or not transmitters located at specific grid points could cause interference to particular neighboring systems. In order to simplify the study of interference to those neighbors, the system configuration is taken into account so as to reduce the number of calculations required by eliminating the study of interference from specific grid points when possible. Two main factors determine whether to eliminate certain grid points from consideration: terrain blockage and the methods of sharing channels between transmitters.

When grid points are completely blocked from line-of-sight to any part of a neighboring system, they can be eliminated from the aggregation of power used in calculating interference to that system. To determine whether to eliminate a grid point for this reason, a shadow study can be conducted from each grid point in the direction of the neighboring system. Separate studies can be conducted for classes of response stations that have different maximum elevations above ground. If there is no area within the protected service area or at any of the registered receiving locations of the neighboring system to which a particular class of station at the grid point has line-of-sight, it can be eliminated from the calculations that determine the power of interfering signals at the neighbor's location. Alternatively, lack of line-of-sight can be evaluated for each location analyzed within the neighboring system and grid points can be eliminated on a location-by-location basis, if that process is more easily implemented. In either of these cases, if power from a multiplicity of response transmitters is to be distributed across an array of grid points, all of the grid points still should be included in such an allocation so that the power ascribed to those points remaining in the analysis will be properly figured.

There are two ways in which a large number of response stations can share channels: They can take turns using the channels so that only one transmitter will be turned on at any particular instant on each channel or subchannel being received by a separate receiver in the system, or they can transmit at the same time and use special filtering techniques at the receiver to separate the signals they are sending simultaneously to that receiver. These two cases will result in different levels of power being radiated into neighboring systems, and therefore they must be analyzed differently.

In the case of response stations that take turns using a channel or subchannel, the grid point and class of station that produces the worst case of interference to each analyzed location in the neighboring system must be determined for each group of response stations that share a channel (e.g., within a response station hub receiving antenna sector). In this case, the interfering signal source can be treated as a single transmitter occupying the full bandwidth of the channel or subchannels used from that location and having a power level equal to the aggregate of the power transmitted on all of the subchannels if subchannels are used.

In the case of response stations that simultaneously share the channel or subchannels, the calculation starts by assigning a number of transmitters in each regional class to each grid point. The population of response stations is assumed to be uniformly distributed within each region. Therefore the number of simultaneous transmitters specified in each regional class is divided by the number of grid points in the region, and each grid point is assigned the resulting number. If there are no grid points within a region, the number of simultaneously operating transmitters is assigned equally to those grid points immediately surrounding the region in addition to those assigned to them from the regions within which they are located. If a specific location is known for one or a group of transmitters, an additional point off the grid may be established to represent them. The total number of transmitters assigned to the grid points and any additional points must equal the maximum number of transmitters specified to be in operation at one time on each channel or subchannel.

Calculating Aggregated Power from Transmitters

The final major step is the calculation of the equivalent isotropic radiated power (EIRP) to be attributed to each of the grid points in the various interference studies so as to be representative of the number of response stations that are expected to be in operation simultaneously within the RSA. When analyzing systems in which the response stations take turns using the channel or subchannels, this means, for each location analyzed in the neighboring system, selecting the grid point and class of station within each sector that radiates the strongest signal to that location and aggregating the power from all such selected grid points and classes, using the maximum EIRP (for all subchannels taken together), the maximum antenna height, and the worst case antenna pattern for that class. For systems in which response stations simultaneously share the channel or subchannels to each receiver at each hub, this means converting the maximum EIRP (for all subchannels taken together) for each regional class at each grid point or additional point, expressed in dBW, to Watts, multiplying by the number of simultaneously operating transmitters in the regional class assigned to that grid point or additional point, and converting the resulting power in Watts back to dBW. At each location analyzed within the neighboring system, the power received from each regional class at all the grid points having line-of-sight to that system is aggregated through conversion from dBW to Watts, addition of power levels, and conversion back to dBW. In each case, the values so calculated are the aggregate powers of all the response station transmitters of each regional class, represented by each grid point or additional point, for use as the undesired signal levels in interference analyses.

In a system using both polarizations, the response stations represented by each grid point are to be assumed to use the polarization of the response station hub antenna sector in which they are located. The appropriate plane-polarized or cross-polarized combined worst-case antenna pattern is to be used in interference studies depending upon the polarization of the station receiving interference. In a system using only one polarization, the effect of antenna sectors can be ignored and the choice between plane- and cross-polarization patterns made identically for all grid points with respect to any particular neighboring system.

Finally, the aggregate power of each active regional class at each active grid point is used in conducting the required interference studies described in this section. For example, to determine that the -73 dBW/m^2 limitation is met, a field strength contour is calculated by first calculating a matrix of field strengths from each regional class at each grid point in the RSA in the region of the PSA or other boundary to be protected using an appropriate terrain-based propagation analysis tool (e.g. free space path loss plus reflection and multiple diffractions). The matrix represents an array of locations on a square grid separated by a short distance (no more than ½-mile). Once the matrix is calculated for each regional class at each grid point or additional point, the matrices are summed by first converting from dBW/m^2 to W/m^2, adding the field strength values from all regional classes at all grid points at each matrix point, and converting from W/m^2 back to dBW/m^2. The summed matrix is then used to route a contour by interpolating between matrix points. The contour so determined should not cross the boundary under consideration.

Similar methods should be used in conducting the other interference studies required in this section. These include the desired-to-undesired (D/U) signal ratio studies for co-channel and adjacent channel interference. In all of these studies, the analysis should use the aggregate power of each regional class at each grid point or additional point, the worst case plane- or cross-polarized antenna pattern, as appropriate, for each regional class, with the antennas at each grid point aimed toward the response station hub, and the maximum antenna height above ground specified for each regional class at each grid point or additional point.

2

Example of Proposed Two-way System Interference Analysis

In order to better understand the demands of the proposed interference prediction methodology submitted in the Petition for Rulemaking ("Petition") on the use of two-way transmissions in wireless cable frequencies, this sample analysis has been prepared. The analysis contained in this document represents a real world application of the proposed interference analysis techniques and a description of how each portion of the analysis was conducted. All of the analyses conducted in this example were made with existing commercial software packages as is the case for interference studies conducted today. Currently, engineering consulting firms use a combination of spreadsheets or custom software and a commercial propagation software package to conduct co-channel and adjacent channel interference studies. The analyses required by the proposed two-way interference methodology can be implemented in exactly the same way. No new software packages were created to accomplish the requirements of the analyses. However, several different commercially available software packages were utilized to accomplish all of the necessary calculations. For example, software produced by EDX Engineering was used for many of the propagation analyses. MapInfo was utilized in determining zip code and population data. And MathCad was used to develop a mathematical model to calculate required grid point spacing. Improvements in time and efficiency could be obtained if any one package incorporated some of the analyses performed in other packages, but there was no limitation on the ability to accomplish the analyses due to lack of software resources.

This example will analyze the ability to license a cell in the Tucson, AZ market utilizing channel MDS2A for return path transmissions. The cell which was constructed for the field test was used to generate field test data only, and not intended for commercial operation. The cell was not constructed in such a way as to provide commercial service, but rather to prove the conservative nature of the interference prediction methodology. In this example, this cell will be designed and the licensing analyses performed as if a commercial service would be present.

Cell Design

There is an existing MDS2A station licensed in the Tucson area, WMI956. Therefore, the application would be prepared as a modification to the existing station. The design will utilize all of the MDS2A channel bandwidth (4 MHZ) for return path transmissions within the cell. Therefore, within the response service area ("RSA") boundary the WMI956 station would not be entitled to interference protection for downstream receive sites from adjacent markets. Instead, the receive site interference protection would be replaced with cochannel and adjacent channel protection to the hub. The relative location of the Tucson cell is shown in Figure 1. The cell is 5 miles in radius.

The application to be licensed will utilize a system where response transmitters in a sector must take turns using an available channel. No sharing of channels within a sector will be allowed. Therefore, within any given sector, only one return path transmitter will occupy a return path channel. The channel bandwidth to be used is 50 KHz. The system will utilize eight sectors approximately 45 degrees in width as seen from the hub site. Each sector will utilize the entire 4 MHZ channel giving the ability to transmit 80 channels within each sector. The polarization will be alternated between horizontal and vertical for each sector in order to give isolation within the cell as shown in Figure 2.

In order to determine the minimum power level required from each response transmitter, assume the required carrier-to-noise at the response station hub including a reasonable fade margin is 35 dB. This will allow the use of relatively high levels of modulation density for the maximum possible data capacity on each subchannel. The noise floor in a 50 KHz channel can be determined from formula (1) on page 67 of the Petitioners previously filed Comments to be -127 dBmW. If we also assume a configuration of the hub site where the antenna gain is 10 dBi, total losses are 8 dB and the noise figure of the RF system is 2 dB, the required output power from each response transmitter is approximately 0.3125 watts or 25 dBm. Therefore, if there are 80 channels in the 4 MHZ bandwidth, the total power in the 4 MHZ channel will be 25 watts or 44 dBm.

Interference Considerations

There are two cochannel and four adjacent channel stations within 100 miles of the proposed cell which must be investigated for interference per the recommendations of the Petition. These stations are described in detail in Appendix A and are summarized below in Table 1.

Stations KNSC282 and KNSC256 are BTA stations and will receive adequate interference protection when the aggregated power from all of the simultaneously operating transmitters in the RSA do not cause a power flux density in excess of -73 dBW/m^2 at the BTA boundary.

Adjacent channel station WMH229 is collocated with the station being modified in this application. Because there will be a significant portion of the WMH229 PSA where interference will exceed the 0 dB limit, an interference acceptance agreement will be needed from this station.

Cochannel station WHB522 and adjacent channel stations WPF47 and WMY446 will have to be analyzed for interference.

In addition, since the existing MDS2A channel is an incumbent station, the aggregated power flux density from the response transmitters must not exceed the -73 dBW/m^2 at the PSA boundary.

Channel	Call Sign	Licensee	Location	Distance
MDS2A	KNSC282	PCTV Gold	Sierra Vista, AZ	79.7 miles
MDS2	WHB522	Phoenix MDS	Phoenix, AZ	98.2 miles
MDS1	WMH229	Alda Tucson	Tucson, AZ	8.0 miles
MDS1	KNSC256	PCTV Gold	Nogales, AZ	58.8 miles
MDS1	WMY446	John McClain	Bisbee, AZ	79.7 miles
MDS1	WPF47	Alda Gold	Phoenix, AZ	98.2 miles

Table 1

Interference Prediction

Step 1 - Definition of Analysis Grid Points

The first step in the interference prediction methodology is to lay out a grid of points within the response service area ("RSA") that will statistically represent the distribution of actual response transmitters within the RSA. These grid points must be distributed evenly throughout the RSA and must begin with four points surrounding the hub and equidistant from the hub. The remainder of the points are then distributed with even spacing throughout the RSA.

A test must be conducted to ensure a sufficient number of grid points is included in the RSA to establish a relatively smooth field of signal levels outside of the RSA. The requirements of this test are specified in detail in the Petition on page 26 of Exhibit C and updated in an attachment to these reply comments. Attached as Figure 3 is a copy of the Tucson cell showing the location of the 168 grid points chosen to generate a smooth field outside of the cell and satisfy the criterion specified in the Petition. Also shown in Figure 3 is the analysis line located ½ mile outside of the cell and the data points spaced at 5 degree increments around the analysis line used in the smooth field calculations. The sectors are also shown in Figure 3 since it will become necessary later in the analysis to assign polarizations to each of the grid points.

The calculations to determine the correct spacing of grid points were performed by a simple program developed in a commercially available software package known as MathCad. The MathCad program takes as inputs the location of the hub, the desired spacing of the grid points, the worst case antenna pattern for each grid point and the maximum EIRP. It then calculates the location of each grid point, the orientation of each antenna back to the hub and the aggregated power level from each grid point in the cell to the analysis line as specified in the

Petition. This program runs these calculations very rapidly and is not technically sophisticated with regard to the type of calculations that are performed. Rather, the calculations are basic geometry and received power level based on free space path loss.

Step 2 - Determination of Regions and Regional Classes of Response Stations

The second step in the process of predicting interference is to define any regions within the RSA which may have non-uniform distribution of population density and could potentially cause "hot spots" of signal radiation within an RSA. However, for the modulation example described in this application where subchannels within a sector are not shared and a worst case assumptions regarding height, power and antenna pattern are used, the population density analysis is not necessary. However, for purposes of showing the simplicity with which the calculations can be done this analysis is included.

An RSA will always have at least one region and may be forced to have more than one region if the population is not uniformly distributed within a cell. Also, the different technical classes of stations to be used throughout the RSA must be specified. These classes are described by the maximum height, maximum EIRP and worst case combined antenna pattern to be utilized.

The test for uniform population density within a cell is described in detail on page 31, Exhibit C of the Petition. The calculation requires that the zip codes within a cell be analyzed for population and area. Attached as Figure 4 is a map showing the zip codes within the proposed Tucson cell. Table 2 contains a summary of the population and area associated with each zip code. Notice many of the zip codes are not completely within the RSA boundary. Therefore, the zip code was proportionately cut to allocate the area and population both within the RSA and the zip code boundary for the calculations.

Table 2 also contains the calculations to determine if the population is relatively uniform in distribution. As can be seen from the last column of the table, all of the individual zip codes are judged to be uniform since the ratio shown, X, is less than or equal to 3. Therefore, the entire RSA can serve as a region and no additional regions need to be defined.

For purposes of this application, one worst case class of response station transmitters will be defined. This characteristics of this class will be (1) a maximum antenna height of 100 feet above ground level, (2) a maximum EIRP of 0.3125 watts and (3) a worst case antenna pattern as defined in the attached Figures 5 and 6 for each polarization .

Zip Code	Population	Area (Sq Miles)	P/A	X
85704	6,349	3.335	1896.02	0.6
85741	14	.007	1974.61	0.6
85718	5,220	5.18	1008.11	0.3
85705	52,749	12.9	4089.07	1.3
85745	22,972	18.17	1264.63	0.4
85719	42,348	8.06	5251.49	1.6
85716	33,856	7.13	4749.19	1.5
85712	16,468	2.96	5559.76	1.7
85711	12,763	2.57	4975.83	1.6
85701	5,409	1.47	3670.35	1.2
85713	41,626	14.29	2913.46	0.9
85707	13	.032	403.73	0.1
85714	10,476	2.33	4487.49	1.4
85746	15	.039	388.43	0.1
Totals	250,278	78.485	3188.86	1.0

Table 2

Step 3 -Determining Transmitter Configuration

If a grid point is terrain blocked to an adjacent market, this grid point can be omitted from the interference analysis. In order to determine if a grid point is terrain blocked, a series of shadow maps from every grid point can be constructed. Several examples of these maps are included in Appendix 1. Unobstructed electrical paths must be determined for each different height above ground level used by a class of station being proposed at each grid point. However, if the first analysis conducted uses the class of station with the greatest height above ground level for the response station, the remaining analyses will be able to ignore those grid points already determined to be terrain blocked.

After grid points have been eliminated based on obstructed electrical paths, the remaining grid points are used to conduct interference analyses.

Step 4 - Calculating Aggregated Power and Interference Levels

The fourth and final step in the process requires a calculation of the aggregated power of all response transmitters operating simultaneously in the RSA. Since each sector can have only one response transmitter operating on a subchannel frequency, the maximum number of simultaneous transmissions on that same subchannel frequency throughout the RSA is equivalent to the number of sectors, eight in this example.

Because in each sector a transmitter could operate on any of the 80 subchannels in the MDS2A bandwidth at any point in the RSA, we must evaluate the potential for interference from all subchannel frequencies at each grid point. To simplify this calculation, the interfering signal source can be treated as a single transmitter located at each grid point operating with the full bandwidth of the channel. Then within each sector, the grid point which creates the worst case interference to each point in a given market can be determined and the power from the worst case points in all sectors can be aggregated to predict the overall interference throughout the adjacent market.

Co-channel Analysis of WHB522

Line-of-sight ("LOS") studies were conducted into the PSA of WHB522 from each of the 168 grid points. It was determined that grid points 115, 135, 141 and 142 are the only points with LOS conditions. Referring back to the grid point map in Figure 3, each of these grid points falls in a different sector. Therefore, each of the grid points represents the worst case point for each sector and all could be operating simultaneously.

An interference analysis was conducted where the aggregated power from each of these grid points was used to conduct an interference study for WHB522. The study is attached as Figure 7. Interference levels were calculated for only those areas with LOS. As the study shows, the interference levels in the LOS areas falls below the 45 dB threshold. Therefore, interference acceptance letters would be needed.

Adjacent Channel Analysis of WPF47 and WMY446

A similar analysis was conducted for the WPF47 and WMY446 adjacent channel stations. The WPF47 station is collocated with the previously described WHB522 station in Phoenix and will therefore have the same grid point with LOS conditions. A study was conducted exactly the same as the WHB522 study but the interference protection requirement was lowered from 45 to 0 dB. This analysis is attached as Figure 8 and shows no adjacent channel interference will be encountered.

Station WMY446 had LOS conditions from grid points 4, 8, 9, 16, 28, 33, 47, 63, 118 and 144. These grid points are not all separated into independent sectors. Grid points 9, 47, 16 and 28 are contained in one sector. Grid point 63 is in a separate sectors. Grid points 118 and 144 are in a separate sector. And grid points 4, 8 and 33 are in yet another sector. Therefore, the worst case interferer must be determined within each sector for each evaluation point in the WMY446 PSA with LOS conditions. This is most easily accomplished by determining the maximum received signal level based on a best server approach from each grid point within a sector. Then, the best server received signal level from each sector can be aggregated to give the total undesired signal level in the WMY446 PSA. An interference study can be generated by calculating the level of the desired signal throughout the PSA and subtracting the aggregated undesired signal at each evaluation point. This study is attached as Figure 9 and shows the WMY446 station is protected.

Power Flux Density Studies

A study must be conducted to show that the power flux density at the PSA boundary does not exceed the -73 dBW/m^2 limit in order to provide protection to BTA stations. A similar study can be conducted where the worst case grid points with LOS are determined in each sector and the aggregate power is used to determine the -73 dBW/m^2 curve.

However, for the example in this application the Tucson cell is small and located deep within the 35 mile PSA of the existing station. A very simple analysis can be performed assume extreme conditions where it is assumed all of the subchannel transmitters are located near the cell center and all add up to give essentially an omnidirectional pattern. The total aggregate power would be 200 watts (8 sectors with 25 watts per sector) and would create a PFD curve approximately 11.1 miles in radius emanating from the cell center. This curve is shown graphically in Figure 10.

Obviously, if the cell had been closer to the PSA boundary, larger than 5 miles radius or utilizing more power than was specified this simple extreme analysis would not be sufficient and the more detailed analysis would have to be conducted.

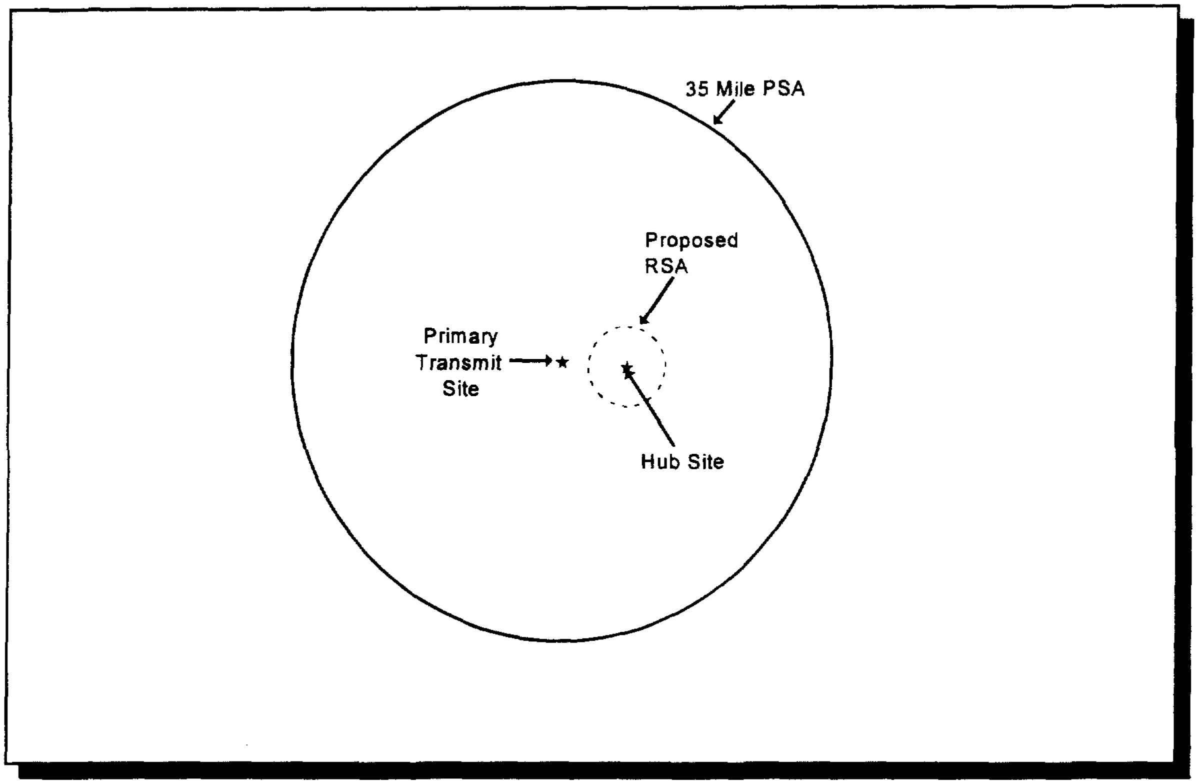


Figure 1

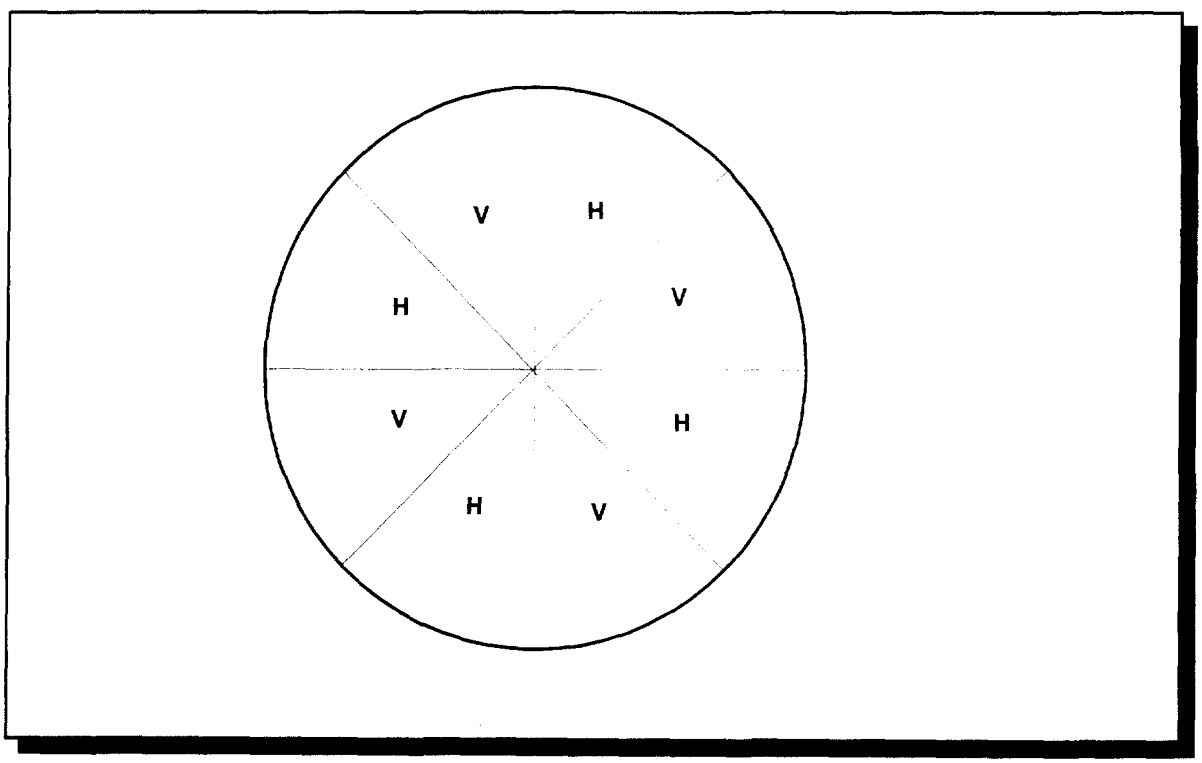


Figure 2

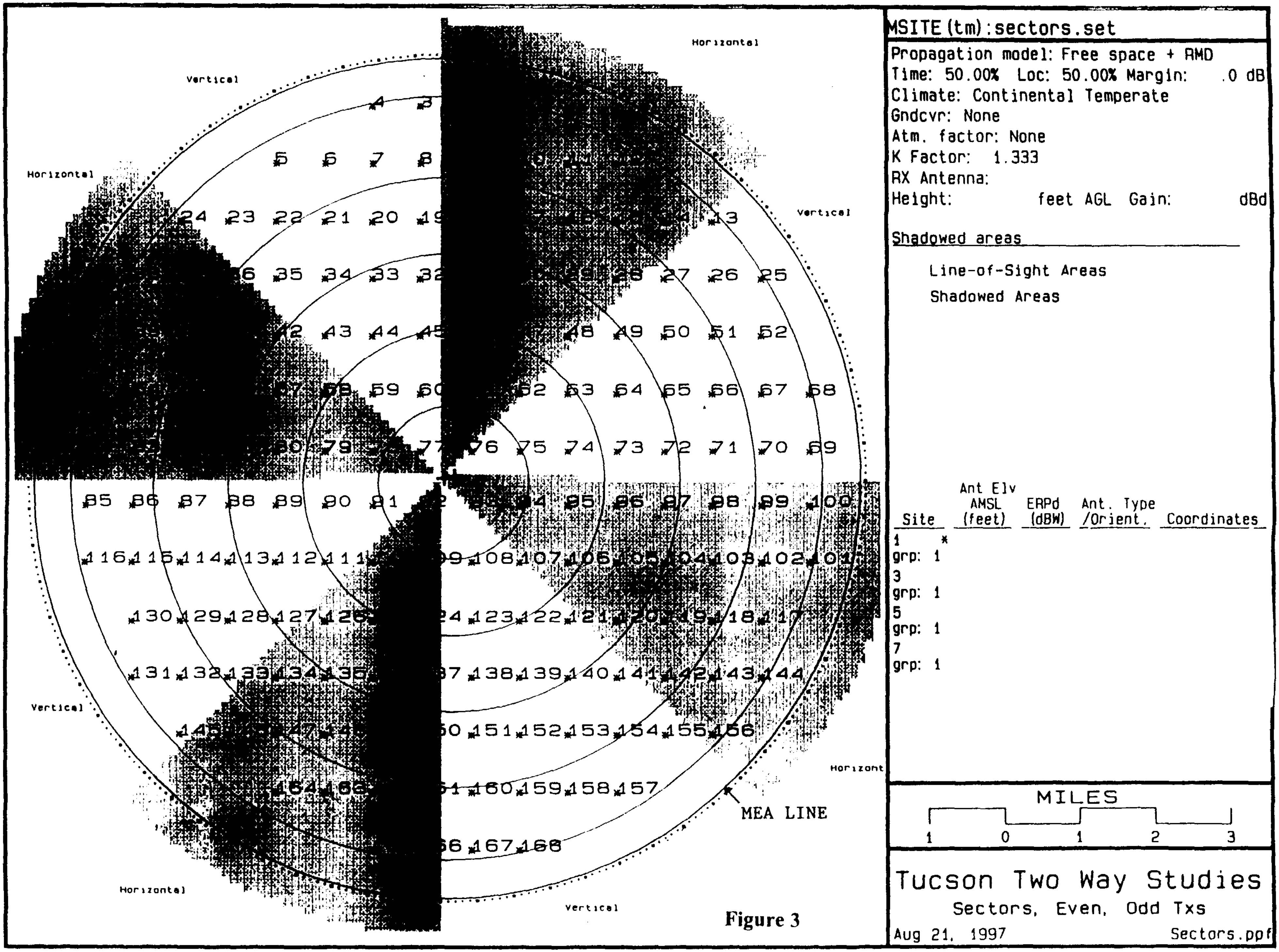

MSITE (tm) :sectors.set
Propagation model: Free space + RMD
Time: 50.00% Loc: 50.00% Margin: .0 dB
Climate: Continental Temperate
Gndcvr: None
Atm. factor: None
K Factor: 1.333
RX Antenna:
Height: feet AGL Gain: dBd
Shadowed areas
Line-of-Sight Areas
Shadowed Areas
Site
Ant Elv AMSL (feet)
ERPd (dBW)
Ant. Type /Orient.
Coordinates
1 *
grp: 1
3
grp: 1
5
grp: 1
7
grp: 1
MILES
1 0 1 2 3
Tucson Two Way Studies
Sectors, Even, Odd Txs
Aug 21, 1997
Sectors.ppf
Horizontal
Vertical
MEA LINE

Figure 3

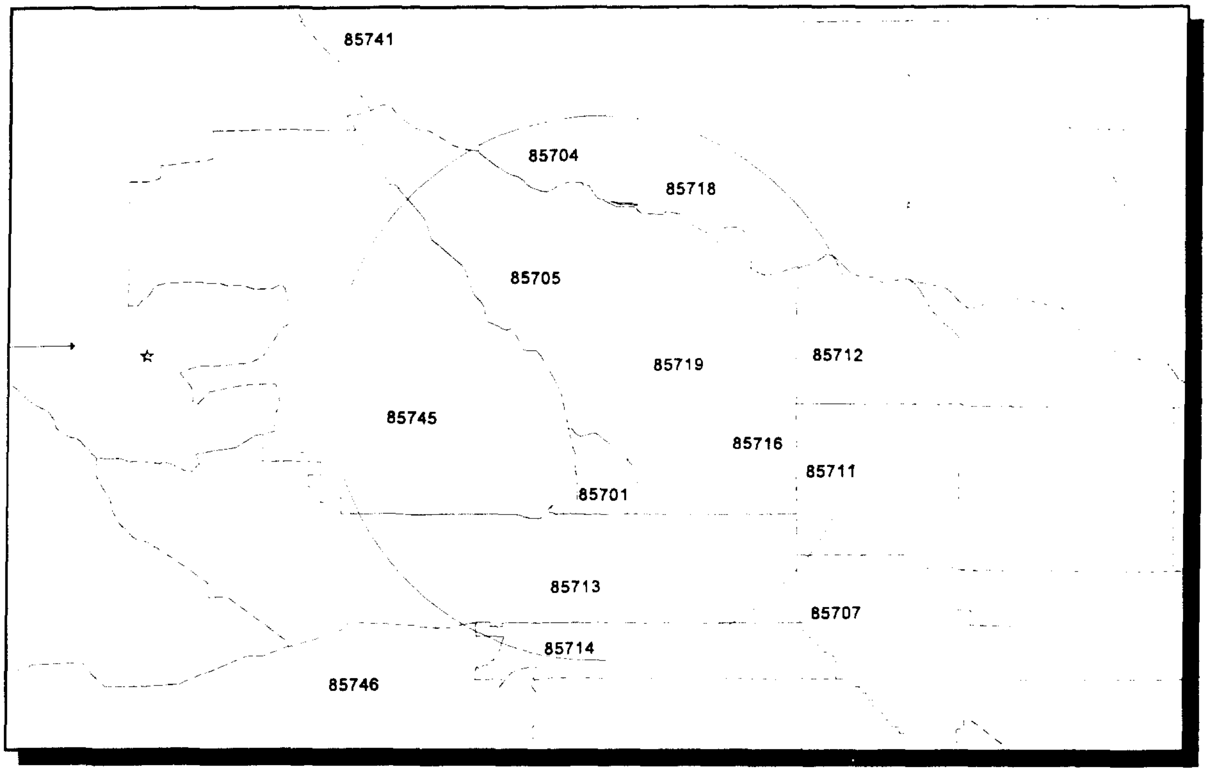
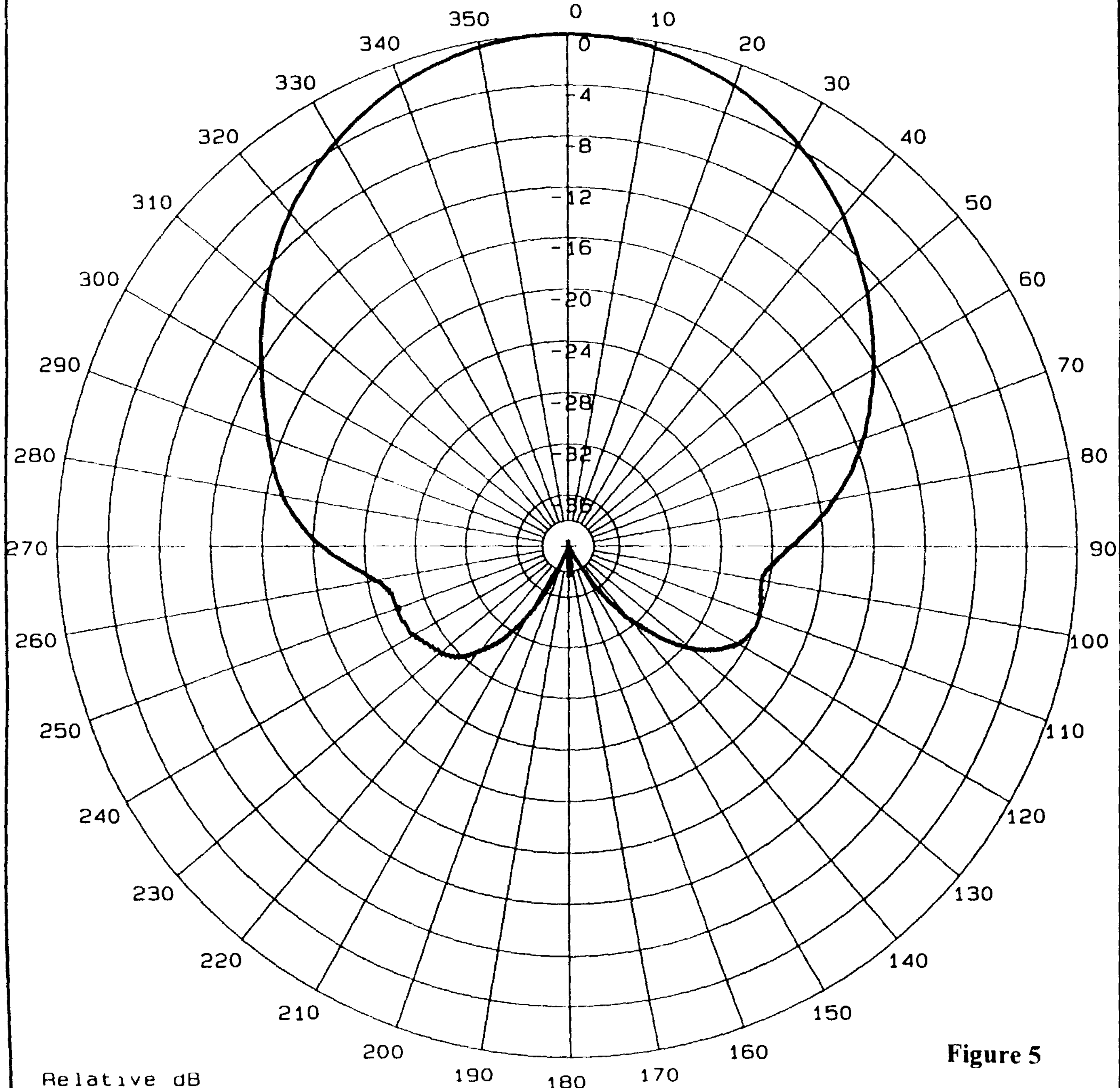

85741
85704
85718
85705
85719
85712
85745
85716
85711
85701
85713
85707
85714
85746

Figure 4

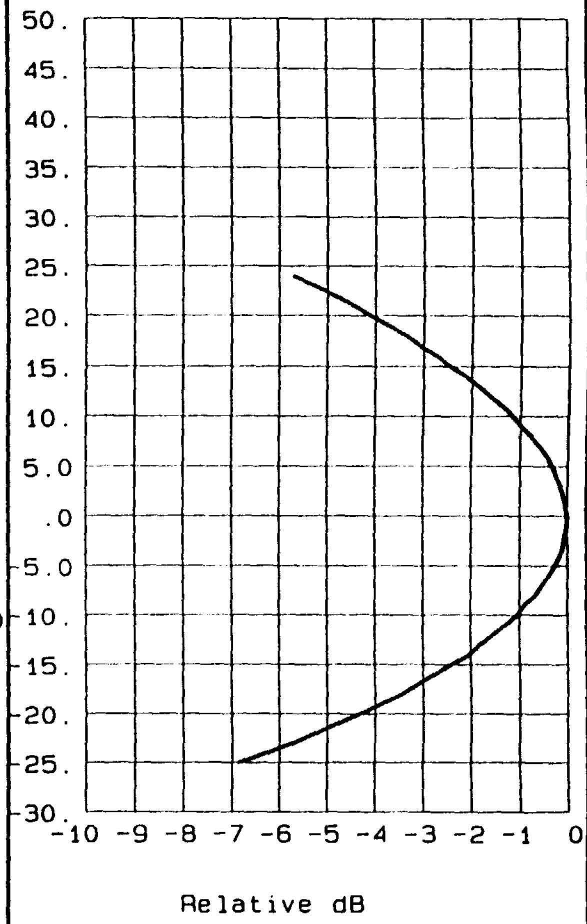
HORIZONTAL PLANE PATTERN



Relative dB

VERTICAL PLANE PATTERN

Azimuth: .0



Pattern file: dl24vpl.edx

CONIFER PL2400
Gt=13dbi
VERTICALLY POLARIZED PATTERN

Figure 5

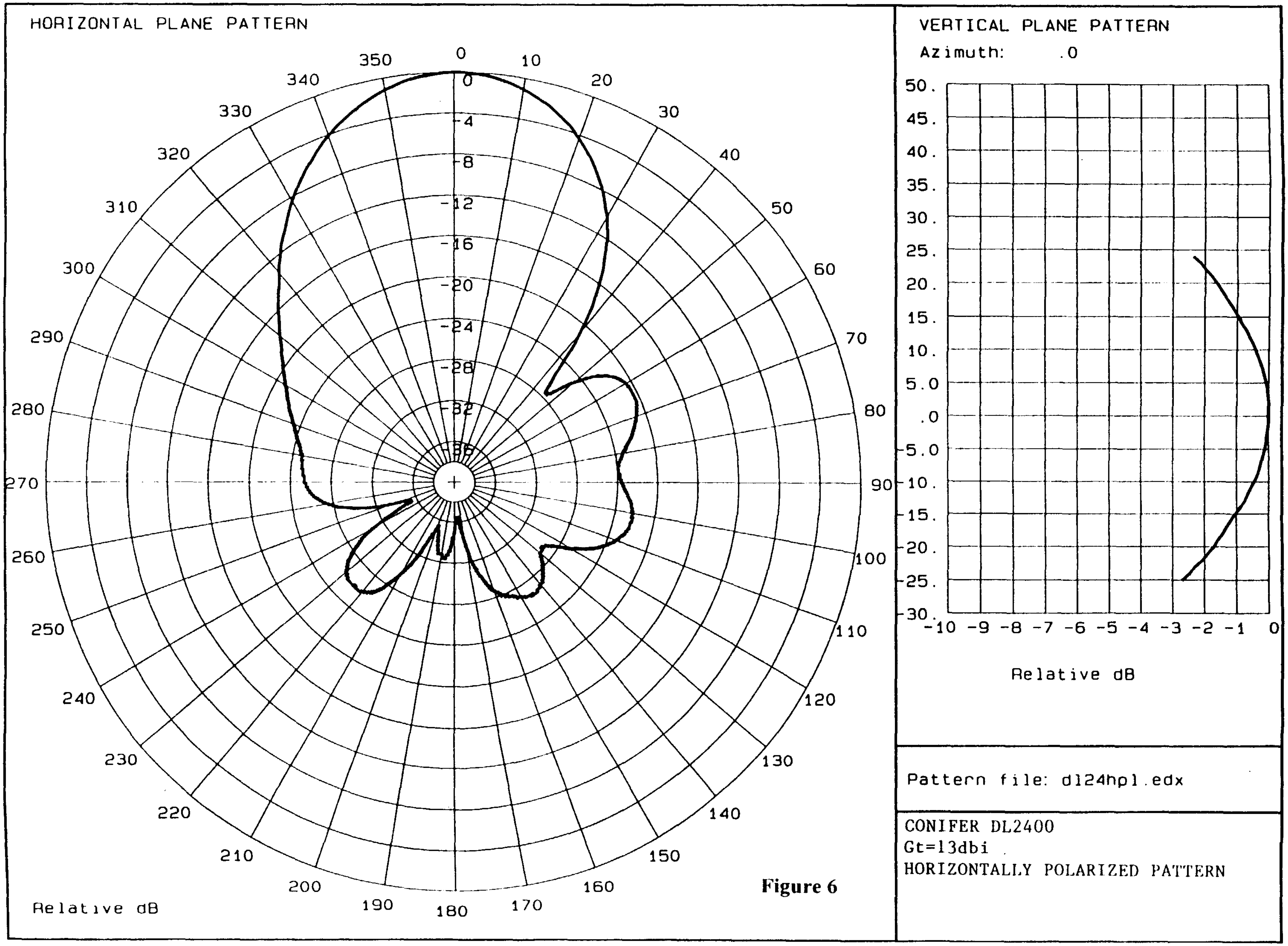

HORIZONTAL PLANE PATTERN
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
320
330
340
350
0
-4
-8
-12
-16
-20
-24
-28
-32
-36
Relative dB
VERTICAL PLANE PATTERN
Azimuth: .0
50.
45.
40.
35.
30.
25.
20.
15.
10.
5.0
.0
-5.0
-10.
-15.
-20.
-25.
-30.
-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0
Relative dB
Pattern file: dl24hpl.edx
CONIFER DL2400
Gt=13dbi
HORIZONTALLY POLARIZED PATTERN

Figure 6

Figure 7
Co-channel Interference Analysis for WHB522